STATUS OF GYPSY MOTH POPULATIONS AT BLACKWATER NATIONAL WILDLIFE REFUGE AND EASTERN NECK NATIONAL WILDLIFE REFUGE

Prepared by

RODNEY L. WHITEMAN
and
BRADLEY P. ONKEN

USDA FOREST SERVICE
FOREST HEALTH PROTECTION
MORGANTOWN, WV 26505

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INTRODUCTION

Over the past several years, gypsy moth populations have reached defoliating levels along the eastern shore of Maryland. The USDI Fish and Wildlife Service manages two wildlife refuges in this area, and have expressed their concern over the potential impact the gypsy moth could have on the oak-pine forests that provides the primary habitat for the threatened and endangered Delmarva fox squirrel. Consequently, the USDA Forest Service was asked to provide technical assistance to evaluate and control gypsy moth populations at these refuges.

On October 6, 14 and 15, 1992, Forest Health Protection personnel conducted gypsy moth egg mass surveys at the Blackwater National Wildlife Refuge (Blackwater NWR) and Eastern Neck National Wildlife Refuge (Eastern Neck NWR). The purpose of these surveys was to determine population densities, assess the potential for defoliation and the need for treatment in 1993. At Eastern Neck NWR, the survey results were also used to evaluate the treatment efficacy of the Gypchek that was applied to 200 acres in 1992.

METHODS

Gypsy moth survey plots were randomly selected based upon available host trees (oaks), size of sample area, uniformity between egg mass counts, and available time. All spray blocks treated in 1992 at Eastern Neck NWR were surveyed. At each sample point, a 1/40th acre fixed-radius plot was established.

The fixed-radius plots (radius 18.6 feet) consisted of a tally of all the new (1992) egg masses observed on the overstory trees, understory vegetation, ground litter and duff. The total number of egg masses observed for each plot was then multiplied by 40 to determine egg masses per acre using the following equation:

RESULTS

Blackwater NWR

Table 1 presents the egg mass survey results at Blackwater NWR. Figures 1 and 2 show the location of the 36 plots. Egg masses were detected at 32 of 36 plots.

The heaviest concentration of egg masses is located near the Longfield area (Figure 1). Egg mass densities in this area ranged from 0-13,640 and averaged 4,405 egg masses per acre. Egg mass densities in the area near the bone yard (Figure 2) were considerably lower and ranged from 0-1,160 with an average of 251 egg masses per acre.

Eastern Neck NWR

Table 2 presents the egg mass survey results at Eastern Neck NWR. Figure 3 shows the location of the 21 plots and the 1992 treatment blocks. Egg masses were detected at 20 of the 21 plots.

Site-wide egg mass densities ranged from 0-7,080 and averaged 1,966 egg masses per acre. Egg mass densities in the 1992 GYPCHEK treatment blocks ranged from 40-7,080 and averaged 2,059 egg masses per acre. This average represents only a 4 percent reduction from the pre-treatment average of 2,155 egg masses per acre.

DISCUSSION

The basic guidelines used to predict the degree of defoliation include evaluation of the defoliation history, number of egg masses/acre, size and condition of the egg masses, available preferred food, terrain and risk of larval blow-in following egg hatch. Potential defoliation is categorized as follows: light (1-30 percent); moderate (31-60 percent); and heavy (61-100 percent).

Gypsy moth populations are sufficient to cause heavy defoliation (61-100 percent) in 3 areas totaling 150 acres, at Blackwater NWR (Figure 4) and in 4 areas, at Eastern Neck NWR totaling 220 acres (Figure 5). No noticeable defoliation is expected elsewhere at either refuge.

The results of this survey should be used in conjunction with your resource management objectives to assess the potential impact that both heavy defoliation and possibly some tree mortality would have in meeting your management goals. Predicting the extent of tree mortality that would occur after one year's defoliation is difficult. Generally speaking however, a stand of trees that is not stressed by other agents during or immediately following a single heavy defoliation will likely pull through with only minor branch dieback and minimal mortality. Trees that have been subjected to two or more years' defoliation, or trees that are stressed by other agents, will have the greatest risk of mortality.

An example of the potential impact, in terms of tree mortality, is provided by a damage evaluation conducted by the USDA Forest Service following a gypsy moth outbreak in 1986-87 on the Allegheny National Forest. In untreated stands consisting of 40-80% oak, the average loss of basal area (mainly oaks) was about 16 percent (range 3-28 percent) following one year of defoliation and 26 percent (range 10-43 percent) after two consecutive years of defoliation. It is believed however, that droughty conditions likely contributed to the level of mortality.

In light of your Regional policy regarding the use of chemical pesticides, three gypsy moth management options are offered for your consideration. The biological intervention options are based upon the following objectives that meet your management goals for the Delmarva fox squirrel: 1) protect host tree foliage to prevent oak mast failure and maintain tree vigor; and 2) prevent tree mortality to preserve the habitat requirements.

No Action Option

It is possible that gypsy moth populations could collapse on their own due to the presence of NPV (nucleopolyhedrosis virus) or the more recently recognized fungal pathogen *Entomophaga maimaiga*. In areas with defoliating level gypsy moth populations (greater than 500 egg masses per acre), viral epizootics generally manifest themselves, but only after significant tree defoliation has already occurred. Gypsy moth populations will usually peak in 2-3 years once they reach defoliating levels and then collapse as a result of NPV or fungal activity. Residual populations following such a collapse will likely remain at low densities for 3-6 years before rebuilding to defoliating levels.

Although it is not possible to accurately assess such events with the information at hand, the moderate to large egg mass size at both Blackwater NWR and Eastern Neck, suggests that these populations are still relatively healthy and a collapse is not likely to occur in 1993.

Trees that are defoliated in excess of 50 percent normally refoliate during the same growing season. Such events cause the trees to expend valuable energy reserves to refoliate, and consequently cause the trees' health to deteriorate and cause mast production to fail. Depending on the condition of the trees at the time of defoliation, reduced growth, branch dieback or in some cases tree mortality, are likely to occur following a single heavy defoliation. Should subsequent defoliation occur the following year, the impact is compound-

ed. Trees that receive light-moderate defoliation (<40 percent) general will not refoliate and there is probably no significant impact other than some reduction in growth and possibly a reduced mast production.

Trees at greater risk for branch dieback or mortality are those that are presently stressed from other factors, such as: 1) soil compaction from roads, sidewalks, parking lots, machinery and/or heavy foot travel; 2) over maturity, 3) drought; 4) shock due to recent timber cutting activities; 5) previous year(s) defoliation; and 6) other insect or disease related problems.

Should no intervention action occur at Blackwater NWR and Eastern Neck NWR to reduce gypsy moth populations in 1993, it is likely that population densities will increase and probably expand to currently uninfested areas next year.

Treatment Option Using *Bacillus thuringiensis* (*B.t.*)

The second option is to use a microbial insecticide to manage gypsy moth populations. The only biological insecticide currently registered and commercially available for gypsy moth control is the microbial insecticide *Bacillus thuringiensis* variety *kurstaki* (*B.t.*). This insecticide is available through several manufacturers and has been used extensively in suppression projects throughout the U.S. in both forested and residential areas. *B.t.* is a bacterium that acts specifically against lepidopterous larvae as a stomach poison and therefore must be ingested. The major mode of action is by mid-gut paralysis which occurs soon after feeding. This results in a cessation of feeding, and death by starvation.

B.t. formulations are available as flowable concentrates, wettable powders, and emulsifiable suspensions. The normal application rates range from 24-30 billion international units (BIUs) per acre in a single application and 16-24 BIUs in double applications. *B.t.* can be applied either undiluted or mixed with water for a total volume of 1/2 - 1 gallon per acre. With proper application, foliage protection and some degree of population reduction can be expected with one application and with two applications both foliage protection and a greater population reduction is likely. The degree of population reduction varies and may depend on, at least in part, the selected application rate, population densities, population health, weather (rain and temperature) and the feeding activity of the larvae following treatment.

Treatment Option Using Gypchek

The third option is to use another microbial insecticide that consists of a nucleopolyhedrosis virus (NPV) and labeled as Gypchek. The NPV has an extremely narrow host range and occurs naturally in gypsy moth populations. Normally, the virus reaches epizootic proportions when gypsy moth populations reach high densities as a result of increased transmission within and between gypsy moth generations. Gypchek is not available commercially as of yet, but the USDA Forest Service and the Animal Plant Health Inspection Service (APHIS) has registered and produced the product in limited quantities. The Forest Service can make it available for use at both Blackwater and Eastern Neck National Wildlife Refuges.

To date, the efficacy of Gypchek treatments to reduce gypsy moth populations has been quite variable. Because of the short period of viral activity on foliage (5-6 days) as well as other biological factors such as feeding activity and weather conditions, it is difficult to project treatment efficacy. We do expect however, that adequate foliage protection would be achieved.

The normal application rate of Gypchek is $5x10^{11}$ polyhedral inclusion bodies (PIBs) per acre. In addition to the virus, the formulation includes Orzan LS (a sunscreen), ProMo liquid supplement (feeding stimulant), Rhoplex B6OA (sticker) and unchlorinated water in a total mix of 2 gallons per acre. The treatment requires that two applications be applied three days apart.

Alternatives

With the previously described options in mind, the following four (4) alternatives are available.

Alternative 1.	-	No action.
Alternative 2.	-	A single aerial application of *B.t.* applied at the rate of 30 BIUs in a total mix of 1/2-1 gallon per acre.
Alternative 3.	-	Two aerial applications of *B.t.* applied at the rate of 24 BIUs in a total mix of 1/2-1 gallon per acre. The second application should be applied 5-7 days following the first.
Alternative 4.	-	Two aerial applications of Gypchek applied at the rate of 5×10^{11} PIB's in a total mix of 2 gallons per acre. The second application should be applied 3 days after the first.

RECOMMENDATIONS

As previously stated, gypsy moth populations are sufficient to cause heavy defoliation in areas totaling 150 acres at Blackwater NWR and 220 acres at Eastern Neck NWR in 1993. As a result, some direct action should be taken to protect tree foliage and prevent tree mortality in order to protect the habitat of the Delmarva fox squirrel.

Our recommendations is to aerially treat these gypsy moth infested areas as described in either Alternatives 2,3 or 4. Either alternative would likely provide foliage protection. Alternatives 2 or 3 are more likely to reduce gypsy moth populations more so than Alternative 4. However Alternative 4 is the most host-specific insecticide and would not impact non-target lepidopterans. Treatment elsewhere at these refuges in 1993 is not necessary.

The 1992 Gypchek treatment at Eastern Neck NWR provided good foliage protection but did not reduce gypsy moth populations below defoliating levels for 1993. This was certainly disappointing, but it may be explained in part because we had to apply one-half the normal dose ($5x10^{6}$ instead of $5x10^{11}$ PIBs per acre), due to the large demand and limited quantities available. Other environmental and biological factors may have been responsible or at least contributed to the failure to reduce these populations, however, these are risks that must be accepted when using biological insecticides. Should the F&WS select Gypchek as their preferred alternative, a full dose ($5x10^{11}$ PIBs) of Gypchek will be made available to treat both Blackwater and Eastern Neck NWRs.

Table 1.– Gypsy Moth Egg Mass Survey Results at Blackwater National Wildlife Refuge, October 14 and 15, 1992.

Plot #	Area	# EM/Acre
1	Longfield	480
2	"	13,640
3	"	12,040
4	"	5,000
5	"	1,960
6	"	400
7	"	80
8	"	360
9	"	3,280
10	"	160
11	"	5,600
12	"	160
13	"	0
14	"	40
15	"	1,240
16	"	1,880
17	"	6,280
18	"	4,560
19	"	12,120
20	"	4,000
21	"	4,160
22	Bone Yard	360
23	"	360
24	"	320
25	"	120
26	"	40
27	"	1,160
28	"	200
29	"	360
30	"	480
31	"	200
32	"	40
33	"	0
34	"	0
35	"	120
36	"	0

Longfield area range = 0-13,640 EM/Acre
Longfield area average = 4,405 EM/Acre
Bone Yard area range = 0-1,160 EM/Acre
Bone Yard area average = 251 EM/Acre

Table 2.-- Gypsy Moth Egg Mass Survey Results at Eastern Neck National Wildlife Refuge, October 6, 1992.

Plot Number	Number EM/Acre
1	4440
2	1440
3	520
4	40
5	440
6	1920
7	4120
8	5320
9	520
10	280
11	7080
12	5960
13	280
14	2160
15	120
16	800
17	40
18	3360
19	2400
20	0
21	40

Range = 0-7080 EM/Acre
Average = 1966 EM/Acre

Figure 1. -- Egg mass survey plot locations at
Blackwater National Wildlife Refuge (area near Longfield),
October 14-15, 1992.

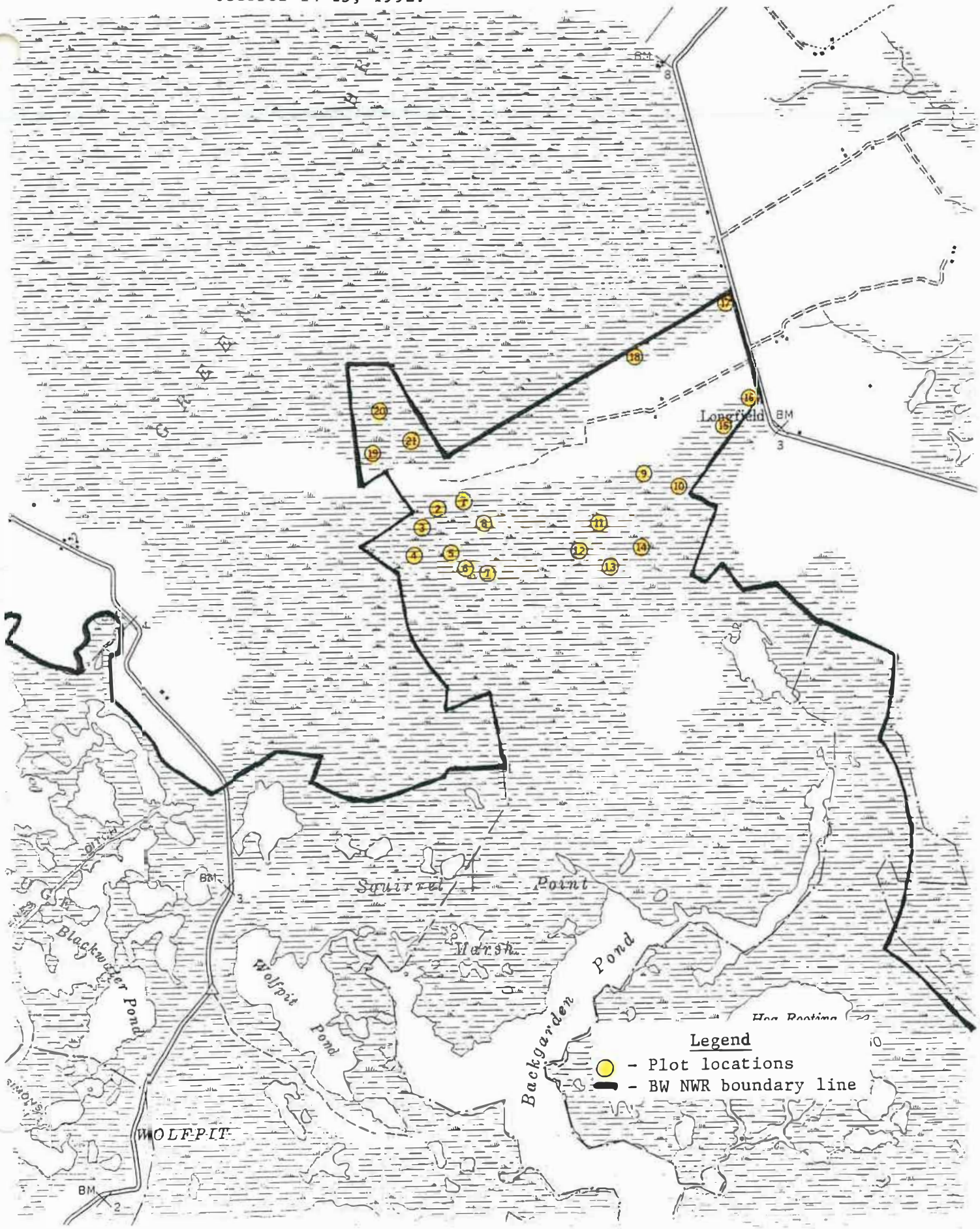


Figure 2. Egg mass survey plot locations at Blackwater National Wildlife Refuge (area near Boneyard), October 14-15, 1992.

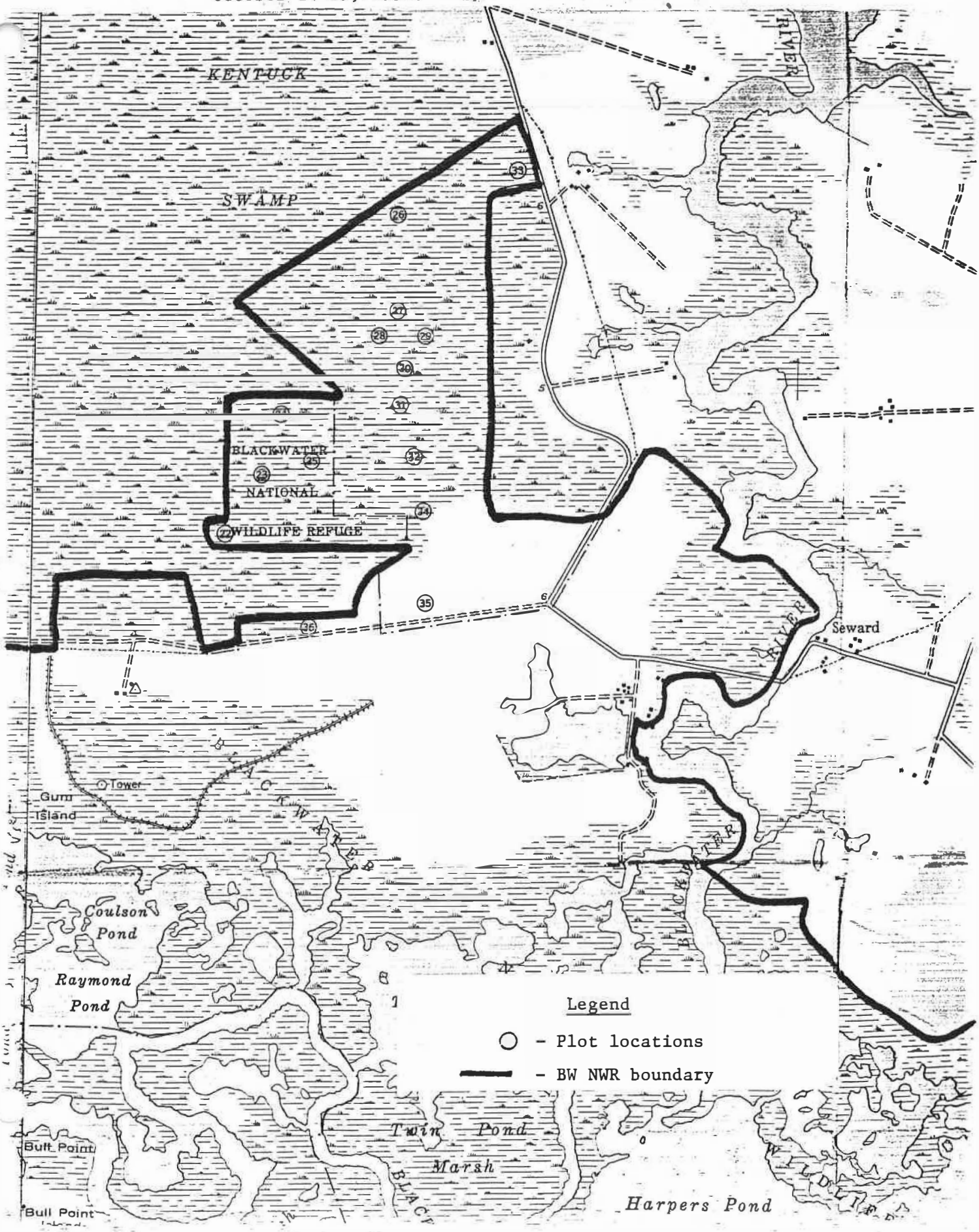
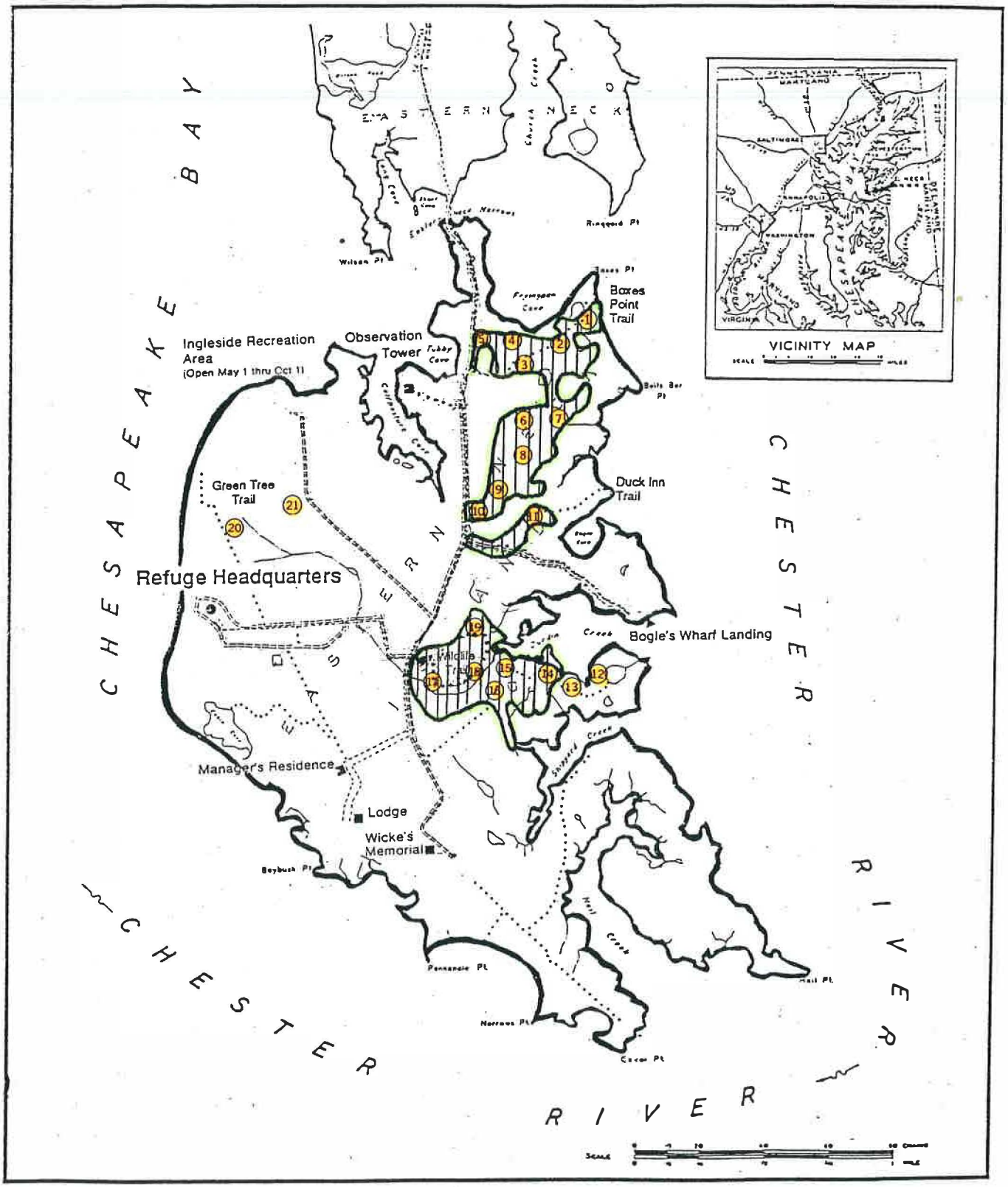


Figure 3.--1992 gypsy moth egg mass survey plot locations and treatment areas at Eastern Neck National Wildlife Refuge.



- Treatment Area 1992

- Plot Locations

Figure 4. -- Areas at Blackwater National Wildlife Refuge where noticeable defoliation is likely to occur.

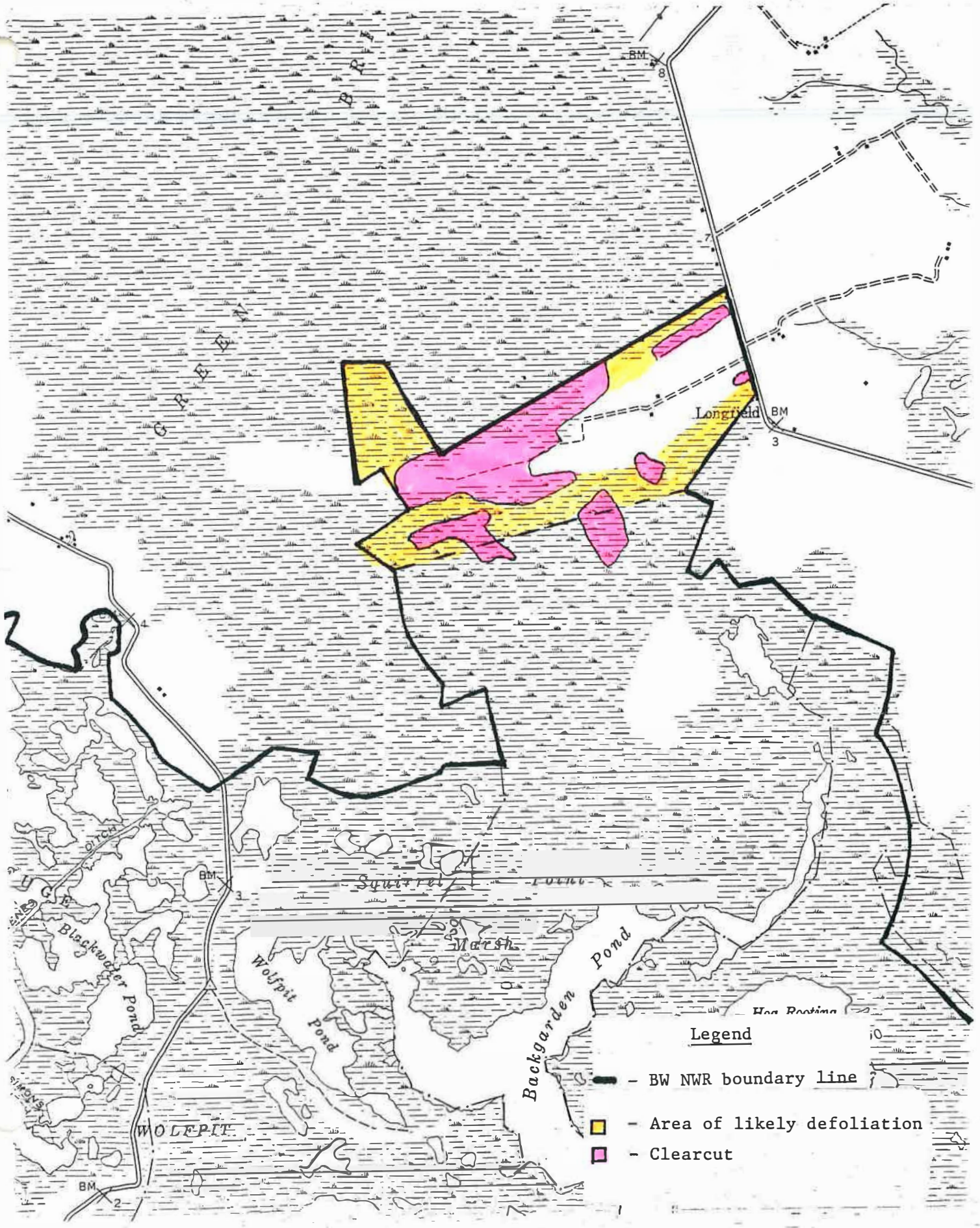
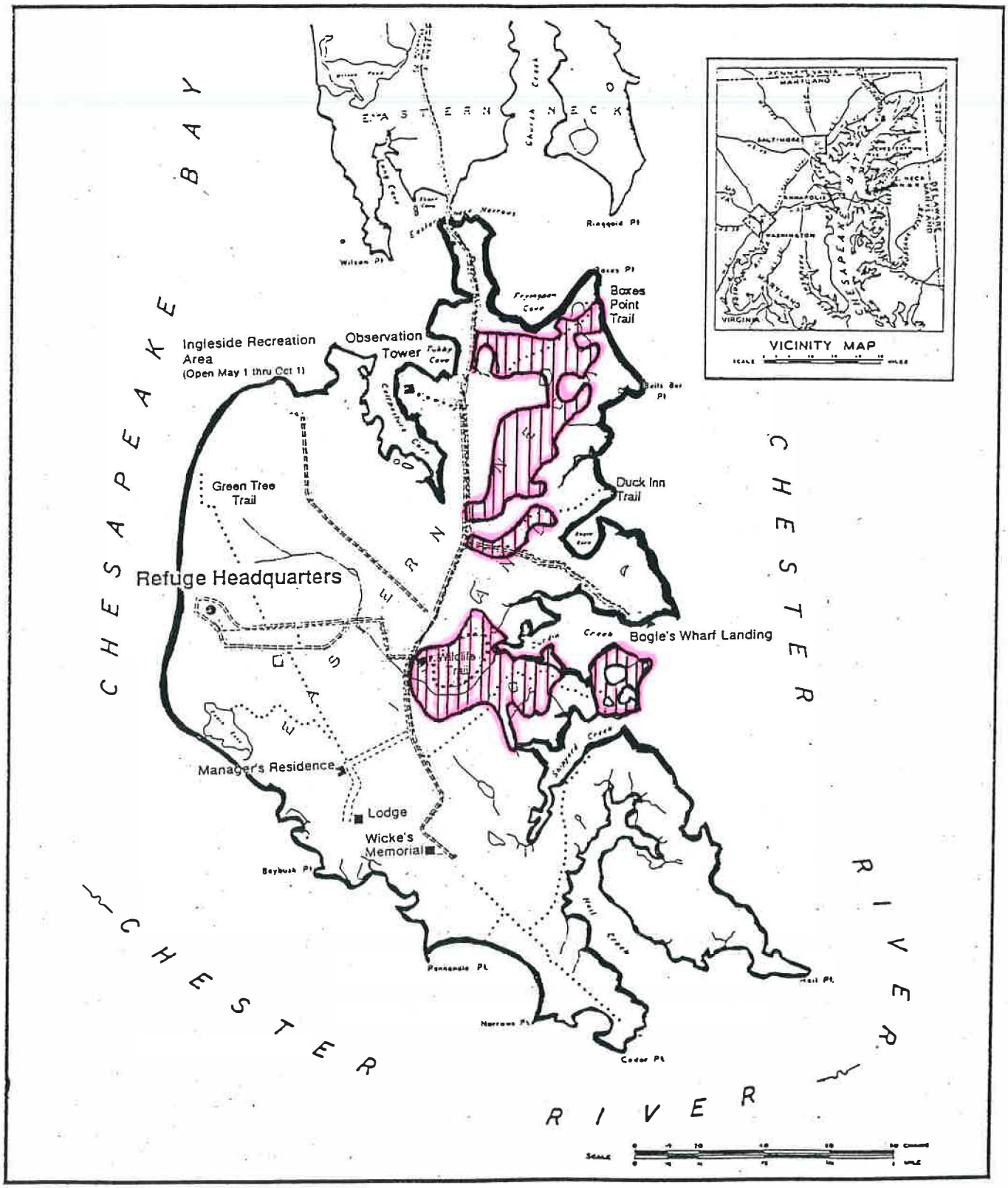


Figure 5.--Areas at Eastern Neck National Wildlife Refuge where noticeable defoliation is likely to occur.



-Areas where noticeable defoliation is likely to occur.

United States Department of Agriculture | Forest Service | Northeastern Area State & Private Forestry | 180 Canfield Street Morgantown, WV 26505

Reply To: 3460

Date: February 5, 1993

Mr. Allen Carter
Regional Forester, R-5
USDI Fish and Wildlife Service
P.O. Box 349
Sufolk, VA 23434

Dear Allen:

Enclosed for your information is a biological evaluation of the current gypsy moth populations at Blackwater and Eastern Neck National Wildlife Refuges. Included in the report is a brief assessment of last year's treatment using Gypchek at Eastern Neck NWR.

To meet your management objectives of preserving the oak-pine habitat for the threatened and endangered Delmarva fox squirrel, we are recommending that 150 acres at Blackwater and 220 acres at Eastern Neck NWR be treated. A no-action option as well as two biological insecticide options are offered for your consideration.

I have been informed that sufficient quantities of Gypchek will be made available for treatment at these refuges should you select this option.

I hope this information will prove useful to you and please call me at (304) 285-1546 if we can be of further assistance.

Sincerely,

Brad Onken

BRADLEY P. ONKEN
Entomologist
Forest Health Protection

Enclosure

cc: Tom Goettel
Bill Giese
AO

BPO/mae